ANNEX K

Technical Standards for Federal "Non-Licensed" Devices

1.0 INTRODUCTION

This Annex sets out the Federal Government regulations and technical specifications under which a low power intentional, unintentional or incidental radiator or device may be operated officially by a Federal Government Agency without an NTIA approved frequency assignment. Non-government operations of these radiators, called non-licensed devices or Part 15 devices, are regulated by the Federal Communications Commission (FCC) Code of Federal Government Regulations, Title 47, Part 15. FCC regulations and standards do not apply to the Federal Government although many low power devices are operated by the Agencies without an NTIA approved frequency assignment. The NTIA thus provides the regulations and standards in this Annex for regulating Federal Government official operations involving low power radiators as non-licensed devices. The regulations and standards in this Annex are a subset of the FCC Part 15 regulations. The IRAC/TSC will continue to maintain an awareness of FCC changes to the Part 15 rules and, where appropriate, incorporate such changes in this Annex.

A "Cross Reference" of the regulations in this Annex and those in the FCC CFR 47, Part 15 regulations is given at the end of this Annex.

1.1 DEFINITIONS

Auditory Assistance Device: An intentional radiator used to provide auditory assistance to a handicapped person or persons. Such a device may be used for auricular training in an educational institution, for auditory assistance at places of public gatherings, such as a church, theater, or auditorium, and for auditory assistance to handicapped individuals, only, in other locations.

Biomedical Telemetry Device: An intentional radiator used to transmit measurements of either human or animal biomedical phenomena to a receiver.

Carrier Current System: A system that transmits radio frequency energy by conduction over the electric power lines. A carrier current system can be designed such that the signals are received by conduction directly from connection to the electric power lines (unintentional radiator) or the signals are received over-the-air due to radiation of the radio frequency signals from the electric power lines (intentional radiator).

Class A Digital Device: A digital device that is for use in a commercial, industrial or business environment, exclusive of a device which is for use by the general public or is intended to be used in the home.

Class B Digital Device: A digital device that is for use in a residential environment notwithstanding use in commercial, business or industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public.

Note: The responsible party may also qualify a device intended to be in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use.

Cordless Telephone System: A system consisting of two transceivers, one a base station that connects to the public switched telephone network and the other a mobile handset unit that communicates directly with the base station. Transmissions from the mobile unit are received by the base station

and then placed on the public switched telephone network. Information received from the switched telephone network is transmitted by the base station to the mobile unit.

Note: The Domestic Public Cellular Radio Telecommunications Service is considered to be part of the switched telephone network. In addition, intercom and paging operations are permitted provided these are not intended to be the primary modes of operation.

Digital Device (previously defined as a computing device): An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other part or section of the NTIA Manual or an intentional radiator subject to Part 3 of this Annex that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities.

Note: Computer terminals and peripherals that are intended to be connected to a computer are digital devices.

External Radio Frequency Power Amplifier: A device which is not an integral part of an intentional radiator as manufactured and which, when used in conjunction with an intentional radiator as a signal source, is capable of amplifying that signal.

Direct Sequence Systems: A spread spectrum system in which the carrier has been modulated by a high speed spreading code and an information data stream. The high speed code sequence dominates the "modulation function" and is the direct cause of the wide spreading of the transmitted signal.

Field Disturbance Sensor: A device that establishes a radio frequency field in its vicinity and detects changes in that field resulting from the movement of persons or objects within its range.

Frequency Hopping Systems: a spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the frequency carrier. The Frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. The wide RF bandwidth needed by such a system is not required by spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop. A frequency hopping system should select operating frequencies from among those in the hop set such that all frequencies are used with equal probability, and all frequency transitions are equally probable.

Hop Set: The set of all frequencies upon which a frequency hopping transmitter may operate.

Incidental Radiator: A device that generates radio frequency energy during the course of its operation although the device is not intentionally designed to generate or emit radio frequency energy. Examples of incidental radiators are DC motors, mechanical light switches, etc.

Intentional Radiator: A device that intentionally generates and emits radio frequency energy by radiation or induction.

Perimeter Protection System: A field disturbance sensor that employs RF transmission lines as the radiating source. These RF transmission line are installed in such a manner that allows the system to detect movement within the protected area.

Unintentional Radiator: A device that intentionally generates radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

1.2 INCIDENTAL RADIATORS

Manufacturers of these devices shall employ good engineering practices to minimize the risk of harmful interference.

An intentional or unintentional radiator shall be constructed in accordance with good engineering design and manufacturing practice. Emanations from the device shall be suppressed as much as

practicable, but in no case shall the emanations exceed the levels specified in these rules.

An intentional or unintentional radiator must be constructed such that the adjustments of any control that is readily accessible by or intended to be accessible to the user will not cause operation of the device in violation of the regulations.

1.3 SUSCEPTIBILITY TO INTERFERENCE

Agencies responsible for equipment compliance are advised to consider the proximity and the high power of non-Government licensed radio stations, such as broadcast, amateur, land mobile, and non-geostationary mobile satellite feeder link earth stations, and of U.S. Government radio stations, which could include high-powered radar systems, when choosing operating frequencies during the design and acquisition of their equipment so as to reduce the susceptibility for receiving harmful interference.

1.4 LABELING REQUIREMENTS

Federal agencies should insure that non-licensed devices purchased under the provisions of Part 7.8 have the appropriate FCC label affixed.

Federal agencies should insure that non-licensed devices developed under the provisions of Part 7.9 and Annex K should have a reference to Part 7.9 and Annex K in the appropriate training and/or operations manual or other documentation.

1.5 EMISSION LIMITS

The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified:

a. On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission. As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, as long as the same bandwidths as indicated for CISPR quasi-peak measurements are employed.

Note: For pulse modulated devices with a pulse-repetition frequency of 20 Hz or less and for which CISPR quasi-peak measurements are specified, compliance with the regulations shall be demonstrated using measuring equipment employing a peak detector function, properly adjusted for such factors as pulse desensitization, using the same measurement bandwidths that are indicated for CISPR quasi-peak measurements.

b. On any frequency or frequencies above 1000 MHz, the radiated limits shown are based on the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified in the regulations, including emission measurements below 1000 MHz, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated. Measurements of AC power line conducted emissions are performed using a CISPR quasi-peak detector, even for devices for which average radiated emission measurements are specified.

c. When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measured field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in those cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

2.0 UNINTENTIONAL RADIATORS

2.1 CONDUCTED LIMITS

1. Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

2. For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed the limits in the following table. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

Frequency of Emission (MHz)	Conducted Limit (microvolts)
0.450-1.705	1000
1.705-30.0	3000

3. For carrier current systems used as unintentional radiators whose emissions are contained within the frequency range 450 kHz to 30 MHz, the provisions of this part shall not apply. Such systems are subject to radiated emission limits as provided in Part 2.2 of this Annex.

4. Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of AC adaptors or battery eliminators or that connect to the AC power line indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

2.2 RADIATED EMISSION LIMITS

1. Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (microvolts/meter)
30-88	100
88-216	150
216-960	200
Above 960	500

2. The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the following:

Frequency of Emission (MHZ)	Field Strength (microvolts/meter)
30-88	90
88-216	150
216-960	210
Above 960	300

3. In the emission tables above, the tighter limit applies at the band edges. Part 1.5 of this Annex specifies the frequency range over which radiated emissions are to be measured.

3.0 INTENTIONAL RADIATORS

3.1 ANTENNA REQUIREMENTS

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible agency shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this part. The agency may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 3.5.2, 3.5.3, or 3.5.4 of this Annex.

3.1.1 EXTERNAL RADIO FREQUENCY POWER AMPLIFIERS AND ANTENNA MODIFICATIONS.

1. Except as otherwise described in paragraph 2. of this section no Government agency shall use or lease any external radio frequency power amplifier or amplifier kit intended for use with a Part 15 intentional radiator.

2. A transmission system consisting of an intentional radiator, an external radio frequency power amplifier, and an antenna, may be authorized for use under this section. However, when a transmission system is authorized as a system, it must always be used as a complete system and must always be used in the configuration in which it was authorized. An external radio frequency power amplifier shall be used only in the system configuration with which the amplifier is authorized and shall not be used as a separate product.

3. Only the antenna with which an intentional radiator is authorized may be used with the intentional radiator.

3.2 RESTRICTED BANDS OF OPERATION

1. Except as shown in paragraph 5, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

2. The table below identifies how each of the restricted bands, as identified above, are used.

Restricted Bands by Use	
Band (MHz)	Allocation/Use
0.090-0.110	Loran C radionavigation
0.495-0.505	Maritime distress frequency
2.1735-2.1905	Mobile distress frequency
4.125-4.128	Global Maritime Distress and Safety System
4.17725-4.17775	Global Maritime Distress and Safety System
4.20725-4.20775	Global Maritime Distress and Safety System
6.215-6.218	Global Maritime Distress and Safety System
6.26775-6.26825	Global Maritime Distress and Safety System
6.31175-6.31225	Global Maritime Distress and Safety System
8.291-8.294	Global Maritime Distress and Safety System
8.362-8.366	Maritime & aeronautical survival craft search and rescue
8.37625-8.38675	Global Maritime Distress and Safety System
8.41425-8.41475	Global Maritime Distress and Safety System
12.29-12.293	Global Maritime Distress and Safety System
12.51975-12.52025	Global Maritime Distress and Safety System
12.57675-12.57725	Global Maritime Distress and Safety System
13.36-13.41	Radio astronomy
16.42-16.423	Global Maritime Distress and Safety System
16.69475-16.69525	Global Maritime Distress and Safety System
16.80425-16.80475	Global Maritime Distress and Safety System
25.5-25.67	Radio astronomy
37.5-38.25	Radio astronomy
73-75.2	73-74.6 MHz: radio astronomy, 74.8-75.2 MHz: aeronautical radionavigation marker beacon (75 MHz) and guard bands
108-121.94	108-117.975 MHz: aeronautical radionavigation (aircraft-to-tower) 117.975-121.9375 MHz: aeronautical mobile for safety and regularity of flight 121.4-121.6 MHz: search and rescue (SARSAT)
123-138	123-123.2 MHz: coordinated search and rescue by mobile, land and aeronautical 123.2-123.8 MHz: aeronautical flight test voice communications 123.5875-137 MHz: aeronautical mobile for safety and regularity of flight 137-138 MHz: satellite down link
149.9-150.05	Radionavigation satellite down link

Restricted Bands by Use	
Band (MHz)	Allocation/Use
156.52475-156.52525	Global Maritime Distress and Safety System
156.7-156.9	Search and rescue (maritime mobile distress and calling on 156.7625-156.8375 MHz)
162.0125-167.17	Wind shear detection around airports and to warn pilots when emergency action is needed, protection of national and visiting foreign dignitaries, and tracking of endangered and dangerous wildlife, law enforcement
167.72-173.2	
240-285	243 MHz (SARSAT), satellite down links, military satellites, glide slope indicators, instrument landing systems
322-335.4	322-328.6 MHz: radio astronomy, 328.6-335.4 MHz: aeronautical radionavigation-instrument landing systems
399.9-410	399.9-400.05 MHz: radionavigation satellite, 400.05-400.15 MHz: standard frequency and time signal, 400.15-402 MHz: satellite down links, 402-406 MHz: meteorological aids (radiosondes), 406-406.1 MHz: emergency position-indicating radiobeacon (EPIRB), 406.1-410 MHz: radio astronomy
608-614	Radio astronomy
960-1240	960-1215 MHz: aeronautical radionavigation, 1215-1240 MHz: satellite down link
1300-1427	1300-1350 MHz: aeronautical radionavigation,1350-1400 MHz: spectral line observation of neutral hydrogen, 1400-1427 MHz: radio astronomy
1435-1626.5	1435-1525 MHz: aeronautical flight test telemetry, 1525-1559 MHz: satellite down links, 1559-1610 MHz: radionavigation satellite down link (GPS) and aeronautical radionavigation, 1610-1626.5 MHz: aeronautical radionavigation, 1610.6-1613.8 MHz: spectral line observation
1645.5-1646.5	Global Maritime Distress and Safety System
1660-1710	1660-1668.4 MHz: radio astronomy, 1668.4-1670 MHz: radio astronomy and radiosonde, 1670-1710 MHz: satellite down link and radiosonde
1718.8-1722.2	Radio astronomy
2200-2300	Satellite down link
2310-2390	Aeronautical flight test telemetry
2483.5-2500	Radiodetermination satellite down link (Geostar)
2655-2900	2655-2690 MHz: radio astronomy and satellite down link, 2690-2700 MHz: radio astronomy, 2700-2900 MHz: air traffic control radars
3260-3267	Spectral line observations (radio astronomy)
3332-3339	Spectral line observations (radio astronomy)
3345.8-3358	Spectral line observation (radio astronomy)
3600-4400	3600-4200 MHz: satellite down link, 4200-4400 MHz: aeronautical radionavigation
4500-5150	4500-4800 MHz: satellite down link, 4800-5000 MHz: radio astronomy, 5000-5150 MHz: aeronautical radionavigation
5350-5460	Aeronautical radionavigation

Restricted Bands by Use	
Band (MHz)	Allocation/Use
7250-7750	Satellite down link
8025-8500	Satellite down link
9000-9200	Aeronautical radionavigation
9300-9500	Radar transponders for maritime search and rescue, airborne weather and ground mapping radar for airborne radionavigation
10600-12700	10600-10700 MHz: radio astronomy, 10700-12200 MHz: satellite down link, 12200-12700 MHz: direct broadcast satellite
13250-13400	Aeronautical radionavigation
14470-14500	Spectral line observation (radio astronomy)
15350-16200	15350-15400 MHz: radio astronomy, 15400-15700 MHz: shuttle landing system, airborne weather and ground mapping radar for radionavigation, 15700-16200 MHz: airport surface detection equipment used to locate and navigate aircraft while on the ground
17700-21400	Satellite down link
22010-23120	22010-22500 MHz: radio astronomy, 22500-23000 MHz: broadcast satellite and radio astronomy, 23000-23070 MHz: fixed/inter-satellite/mobile, 23070-23120 MHz: radio astronomy
23600-24000	Radio astronomy
31200-31800	Radio astronomy
36430-36500	Radio astronomy
Above 38600	Satellite down link, Radio astronomy

3. Except as provided in paragraphs 5 and 6, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Part 3.4 of this Annex. At frequencies equal to or less than 1000 MHz, compliance with the limits in Part 3.4 of this Annex shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Part 3.4 of this Annex shall be demonstrated based on the average value of the measured emissions. The provisions in Part 1.5 of this Annex apply to these measurements.

4. Except as provided in paragraphs 5 and 6, regardless of the field strength limits specified elsewhere in this Annex, the provisions of this part apply to emissions from any intentional radiator.

5. The following devices are exempt from the requirements of this part:

a. Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph 1, the sweep is never stopped with the fundamental emission within the bands listed in paragraph 1, and the fundamental emission is outside of the bands listed in paragraph 1 more that 99% of the time the device is actively transmitting, without compensation for duty cycle.

b. Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

6. Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of Section 3.5.16 of this Annex shall not exceed the limits

specified in paragraph 2 of Section 3.5.16.

3.3 CONDUCTED LIMITS

1. For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

2. The limit in paragraph 1 shall not apply to intentional radiators operated as carrier current systems in the frequency range of 450 kHz to 30 MHz. Such systems are subject to radiated emission limits as provided in Parts 3.2 and 3.4 of this Annex.

3. Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

3.4 RADIATED EMISSION LIMITS, GENERAL REQUIREMENTS

1. Except as provided elsewhere in this part, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meters)	Measurement Distance (meters)
0.009-0.490	2400/F (kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.0	30	30
30-88	100*	30
88-216	150*	3
216-960	200*	3
Above 960	500	3

* Except as provided in paragraph 6, fundamental emissions from intentional radiators operating under this part shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz, or 470-806 MHz.

2. In the emission table above, the tighter limit applies at the band edges.

3. The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other parts and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

4. The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

5. The provisions in Part 1.5 of this Annex for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

6. Operation in the frequency bands allocated to TV broadcast stations:

a. Perimeter protection systems operating under the provisions of the part of Annex K in the frequency bands allocated to TV broadcast stations, as shown in Chapter 4 of this Manual, shall contain their fundamental emissions within the frequency bands 54-72 MHz and 76-88 MHz. Further, the use of such perimeter protection systems is limited to industrial, business and commercial applications.

b. Biomedical telemetry devices operating under the provisions of this part of Annex K in the frequency bands allocated to TV broadcast stations, as shown in Chapter 4 of this Manual, shall contain

their fundamental emissions within the frequency band 312-566 MHz. Further, the marketing and the use of biomedical telemetry devices operating under this paragraph shall be limited to hospitals.

3.5 RADIATED EMISSION LIMITS, ADDITIONAL PROVISIONS

3.5.1 Additional Provisions to the General Radiated Emission Limitations

1. The regulations in Sections 3.5.2 through 3.5.19 of this Annex provide alternatives to the general radiated emission limits for intentional radiators operating in specified frequency bands. Unless otherwise stated, there are no restrictions as to the types of operation permitted under these sections.

2. In most cases, unwanted emissions outside of the frequency bands shown in these alternative provisions must be attenuated to the emission limits shown in Part 3.4 of this Annex. In no case shall the level of the unwanted emission from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.

3. For those bands of frequencies where alternative radiated emission limitations apply and for which a frequency stability is not specified, it is recommended that the fundamental frequency be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

4. Where the following sections specify limits on the bandwidth of the emissions, the bandwidth limits include the effects of frequency sweeping, frequency hopping, and other modulation techniques which may be employed.

3.5.2 Operation in the Band 160-190 kHz

1. The total input power to the final radio frequency stage (exclusive of filament or heater power) shall not exceed one watt.

2. The total length of the transmission line, antenna, and ground lead (if used) shall not exceed 15 meters.

3. All emissions below 160 kHz or above 190 kHz shall be attenuated at least 20 dB below the level of the unmodulated carrier. Determination of compliance with the 20 dB attenuation specification may be based on measurements at the intentional radiator's antenna output terminal unless the intentional radiator uses a permanently attached antenna, in which case compliance shall be demonstrated by measuring the radiated emissions.

3.5.3 Operation in the Band 510-1705 kHz

1. The total input power of the final radio frequency stage (exclusive of filament or heater power) shall not exceed 100 milliwatts.

2. The total length of the transmission line, antenna and ground lead (if used) shall not exceed 3 meters.

3. All emissions below 510 kHz or above 1705 kHz shall be attenuated at least 20 dB below the level of the unmodulated carrier. Determination of compliance with the 20 dB attenuation specification may be based on measurements at the intentional radiator's antenna output terminal unless the intentional radiator uses a permanently attached antenna, in which case compliance shall be demonstrated by measuring the radiated emissions.

3.5.4 Operation in the Band 525-1705 kHz

1. The provisions of this section are restricted to the operation of an AM broadcast station on a college or university campus or on the campus of any other educational institution. Operation is restricted to the grounds of the campus. For the band 535-1705 kHz, the frequency of operation shall be chosen such that operation is not within the protected field strength contours of licensed AM stations.

2. On the campus, the field strength of emissions appearing outside of this frequency band shall not exceed the general radiated emission limits shown in Part 3.4 of this Annex as measured from the radiating source. There is no limit on the field strength of emissions appearing within this frequency band, except that the provisions of Part 7.8 of the NTIA Manual continue to apply.

3. At the perimeter of the campus, the field strength of any emissions, including those within the

frequency band 525-1705 kHz shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

4. The conducted limits specified in Part 3.3 of this Annex apply to the radio frequency voltage on the public utility power lines outside of the campus. Due to the large number of radio frequency devices which may be used on the campus, contributing to the conducted emissions, as an alternative to measuring conducted emissions on the AC power lines outside of the campus, it is acceptable to demonstrate compliance with this provisions by measuring each individual intentional radiator employed in the system at the point where it connects to the AC power lines. As provided in Part 3.3, paragraph 2 of this Annex, if only a carrier current system is employed, the AC power line conducted limits do not apply. However, the radiated emission limits provided in this section apply to carrier current systems.

3.5.5 Operation in the Band 1.705-10 MHz

1. The field strength of any emission within the band 1.705-10 MHz shall not exceed 100 microvolts/meter at a distance of 30 meters. However, if the bandwidth of the emission is less than 10% of the center frequency, the field strength shall not exceed 15 microvolts/meter or (the bandwidth of the device in kHz) divided by (the center frequency of the device in MHz) microvolts/meter at a distance of 30 meters, whichever is the higher level. For the purposes of this section, bandwidth is determined at the point 6 dB down from the modulated carrier. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in Part 1.5 paragraph 2 of this Annex for limiting peak emissions apply.

2. The field strength of emissions outside of the band 1.705-10 MHz shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

3.5.6 Operation Within the Band 13.553-13.567 MHz

1. The field strength of any emission within this band shall not exceed 10,000 microvolts/meter at 30 meters.

2. The field strength of any emissions appearing outside of this band shall not exceed the general radiated emission limits shown in Part 3.4 of this Annex.

3. The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of !20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

3.5.7 Operation Within the Band 26.96-27.28 MHz

1. The field strength of any emission within this band shall not exceed 10,000 microvolts/meter at 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

2. The field strength of any emissions which appear outside of this band shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

3.5.8 Operation Within the Band 40.66-40.70 MHz

1. Unless operating pursuant to the provisions in Section 3.5.9 of this Annex, the field strength of any emission within this band shall not exceed 1000 microvolts/meter at 3 meters.

2. As an alternative to the limit in paragraph 1, perimeter protection systems may demonstrate compliance with the following: the field strength of any emissions within this band shall not exceed 500 microvolts/meter at 3 meters, as determined using measurement instrumentation employing an average detector. The provisions of Part 1.5 of this Annex for limiting peak emissions apply where compliance of these devices is demonstrated under this alternative emission limit.

3. The field strength of any emissions appearing outside of this band shall not exceed the general

radiated emission limits in Part 3.4 of this Annex.

4. The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of !20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

3.5.9 Periodic Operation in the Band 40.66-40.70 MHz and Above 70 MHz

1. The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph 5 of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Radio control of toys is not permitted. Continuous transmissions, such as voice or video, and data transmissions, are not permitted. The prohibition against data transmissions does not preclude the use of recognition codes. Those codes are used to identify the sensor that is activated or to identify the particular component as being part of the system. The following conditions shall be met to comply with the provisions for this periodic operation:

a. A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

b. A transmitter activated automatically shall cease transmission within 5 seconds after activation.

c. Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions to determine system integrity or transmitters used in security or safety applications are allowed if the periodic rate of transmission does not exceed one transmission of not more than one second duration per hour for each transmitter.

d. Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

2. In addition to the provisions of Part 3.2 of this Annex, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meters)	Field Strength of Spurious Emissions (microvolts/meters)
40.66-40.70	2,250	225
70-130	1,250	125
130-174	1,250 to 3,750*	125 to 375*
174-260	3,750	375
260-470	2,750 to 12,500*	375 to 1,250*
Above 470	12,500	1,250

* linear interpolations

a. The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

b. Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Part 1.5 of this Annex for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Part 3.2 of this Annex shall be demonstrated using measurement instrumentation with a CISPR quasi-peak detector.

c. The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average limits shown in this table or to the general limits shown in Part 3.4 of this Annex, as measured with a CISPR quasi-peak detector, whichever limit permits a higher field strength.

3. The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

4. For devices operating within the frequency band 40.66-40.70 MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be ±0.01%. This frequency tolerance shall be maintained for a temperature variation of !20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

5. Intentional radiators may operate at a periodic rate exceeding that specified in paragraph 1 and may be employed for any type of operation, including operation prohibited in paragraph 1, provided the intentional radiator complies with the provisions of paragraphs 2 through 4 of this section, except the field strength table in paragraph 2 is replaced by the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500*	50 to 150*
174-260	1,500	150
260-470	1,500 to 5,000*	150 to 500*
Above 470	5,000	500

* linear interpolations

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

3.5.10 Operation Within the Bands 46.60-46.98 MHz and 49.66-50.0 MHz

1. The provisions shown in this section are restricted to cordless telephones.

2. An intentional radiator used as part of a cordless telephone system shall operate on one or more of the following frequency pairs:

Channel	Base Transmitter (MHz)	Handset Transmitter (MHz)
1	46.610	49.670
2	46.630	49.845
3	46.670	49.860
4	46.710	49.770
5	46.730	49.875
6	46.770	49.830
7	46.830	49.890
8	46.870	49.930
9	46.930	49.990
10	46.970	49.970

3. The field strength of the fundamental emission shall not exceed 10,000 microvolts/meter at 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

4. The fundamental emission shall be confined within a 20 kHz band centered on the actual carrier frequency. Modulation products outside of this 20 kHz band shall be attenuated at least 26 dB below the level of the unmodulated carrier or to the general limits in Part 3.4 of this Annex, whichever permits the higher emission levels. Emissions on any frequency more than 20 kHz removed from the center frequency shall consist solely of unwanted emissions and shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

5. If the device provides for the connection of external accessories, including external electrical input signals, the device must be tested with the accessories attached. The emission tests shall be performed with the device and accessories configured in a manner which tends to produce the maximum level of emissions within the range of variations that can be expected under normal operating conditions.

6. The frequency tolerance of the carrier signal

shall be maintained within ±0.01% of the operating frequency. The tolerance shall be maintained for a temperature variation of !20 degrees C to +50 degrees C at normal supply voltage, and for variation in the primary voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

3.5.11 Operation Within the Band 49.82-49.90 MHz

1. The field strength of any emission within this band shall not exceed 10,000 microvolts/meter at 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

2. The field strength of any emissions appearing between the band edges and up to 10 kHz above and below the band edges shall be attenuated at least 26 dB below the level of the unmodulated carrier or to the general limits in Part 3.4 of this Annex, whichever permits the higher emission levels. The field strength of any emissions removed by more than 10 kHz from the band edges shall not exceed the general radiated emission limits in Part 3.4 of this Annex. All signals exceeding 20 microvolts/meter at 3 meters shall be reported in the application for certification.

3.5.12 Operation in the Bands 72.0-73.0 MHz and 75.4-76.0 MHz

1. The intentional radiator shall be restricted to use as an auditory assistance device.

2. Emissions from the intentional radiator shall be confined within a band 200 kHz wide centered on the operating frequency. The 200 kHz band shall lie wholly within the above specified frequency ranges.

3. The field strength of any emissions within the permitted 200 kHz band shall not exceed 80 millivolts/meter at 3 meters. The field strength of any emissions radiated on any frequency outside of the specified 200 kHz band shall not exceed 1500 microvolts/meter at 3 meters. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3.5.13 Operation in the Band 88-108 MHz

1. Emissions from the intentional radiator shall be confined within a band 200 kHz wide centered on the operating frequency. The 200 kHz band shall lie wholly within the frequency range 88-108 MHz.

2. The field strength of any emissions within the permitted 200 kHz band shall not exceed 250 microvolts/meter at 3 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3. The field strength of any emissions radiated on any frequency outside of the specified 200 kHz band shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

3.5.14 Operation in the Band 174-216 MHz

1. Operation under the provisions of this section is restricted to biomedical telemetry devices.

2. Emissions from the device shall be confined within a 200 kHz band which shall lie wholly within the frequency range 174-216 MHz.

3. The field strength of any emissions radiated within the specified 200 kHz band shall not exceed 1500 microvolts/meter at 3 meters. The field strength of emissions radiated on any frequency outside of the specified 200 kHz band shall not exceed 150 microvolts/meter at 3 meters. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3.5.15 Operation in the Band 890-940 MHz

1. Operation under the provisions of this section is restricted to devices that use radio frequency energy to measure the characteristics of a material. Devices operated pursuant to the provisions of this section shall not be used for voice communications or the transmission of any other type of message.

2. The field strength of any emissions radiated within the specified frequency band shall not exceed 500 microvolts/meter at 30 meters. The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3. The field strength of emissions radiated on any frequency outside of the specified band shall not exceed the general radiated emission limits in Part 3.4 of this Annex.

4. The device shall be self-contained with no external or readily accessible controls which may be adjusted to permit operation in a manner inconsistent with the provisions of this section. Any antenna that may be used with the device shall be permanently attached thereto and shall not be readily modifiable by the user.

3.5.16 Operation Within the Bands 902-928 MHz, 2435-2465 MHz, 5785-5815 MHz, 10500-10550 MHz and 24075-24175 MHz

1. Operation under the provisions of this section is limited to intentional radiators used as field disturbance sensors, excluding perimeter protection systems.

2. The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (millivolts/meters)	Field Strength of Harmonics (millivolts/meters)
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25.0
24075-24175	2500	25.0

a. Regardless of the limits show in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in Part 3.2 of this Annex, shall not exceed the field strength limits shown in Part 3.4 of this Annex. Harmonic emissions in the restricted bands at and above 17.7 GHz, and below 40 GHz, shall not exceed the following field strength limits:

(1) For field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

(2) For all other field disturbance sensors, 7.5 mV/m.

(3) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands fully comply with the limits given in Part 3.4 of this Annex. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as fork lifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

b. Field strength limits are specified at a distance of 3 meters.

c. Emissions radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Part 3.4 of this Annex, whichever is the lesser attenuation.

d. The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3.5.17 Operation Within the Bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

1. Operation under the provisions of this section is limited to frequency hopping and direct sequence spread spectrum intentional radiators that comply with the following provisions:

a. Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. The system shall hop to channel frequencies that are selected at

the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(1) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(2) Frequency hopping systems operating in the 2400-2483.5 MHz and 5725-5850 MHz bands shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

b. For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

2. The maximum peak output power of the intentional radiator shall not exceed the following:

a. For frequency hopping systems operating in the 2400-2483.5 MHz or 5725-5850 MHz band and for all direct sequence systems: 1 watt.

b. For frequency hopping systems operating in the 902-928 MHz: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under subparagraph 1.a.(1) of this section.

c. Except as shown below, with a transmitting antenna having directional gain greater than 6 dBi, the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(1) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(2) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations my employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

(3) Fixed, point-to-point operation, as used in subparagraphs 2.c.(1) and 2.c.(2) of this subsection, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the radiator shall contain language in the instillation instructions informing the operator and the installer of this responsibility.

(4) Systems operating under the provisions of this part shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the national guidelines expressed in this manual in Section 8.2.28.

3. In any 100 kHz bandwidth outside the frequency band, in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, whichever yields the highest value. Attenuation below the general limits specified in paragraph 1 of Part 3.4 is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Part 3.2, must also comply with the radiated emission limits specified in paragraph 1 of Part 3.4.

4. For direct sequence systems, the peak power spectral density conducted from the intentional

radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5. The processing gain of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined using one of the following methods:

a. As measured at the demodulated output of the receiver: the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the systems spreading code turned on.

b. As measured using the CW jamming margin method: a signal generator is stepped in 50 kHz increments across the passband of the system, recording at each point the generator level required to produce the recommended Bit Error Rate (BER). This level is the jammer level the output power of the intentional radiator is measured at the same point. Then jammer-to-signal ratio (J/S) is then calculated, discarding the worst 20% of the J/S data points. The lowest remaining J/S ratio is used to calculate the processing gain, as follows: $Gp = (S/N)_O + Mj + Lsys$, where Gp = processing gain of the system, $(S/N)_O$ = signal-to-noise ratio required for the chosen BER, Mj = J/S ratio, and Lsys = system losses. Note that total losses in a system, including intentional radiator and receiver, should be assumed to be no more than 2 dB.

6. Hybrid systems that employ a combination of both direct sequence and frequency hopping modulation techniques shall achieve a processing gain of at least 17 dB from the combined techniques. The frequency hopping operation of the hybrid system, with the direct sequence operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The direct sequence operation of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph 4 of this Section.

7. Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

8. The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Note: Spread spectrum systems are sharing these bands on a non-interference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U.S. Government operations in the 902-938 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.5.18 Operation Within the Bands 902-928 MHz 2400-2483.5 MHz, 5725-5875 MHz and 24.0-24.25 GHz

1. The field strength from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

2. Field strength limits are specified at a distance of 3 meters.

3. Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Part 3.4 of this Annex, whichever is the lesser attenuation.

4. As shown in Part 1.5 paragraph 2 of this Annex, for frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

3.5.19 Operation Within the Bands 2.9-3.26 GHz, 3.267-3.332 GHz, 3.339-3.3458 GHz and 3.358-3.6 GHz

1. Operation under the provisions of this section is limited to automatic vehicle identification systems (AVIS) which use swept frequency techniques for the purpose of automatically identifying transportation vehicles.

2. The field strength anywhere within the frequency range swept by the signal shall not exceed 3000 microvolts/meter/MHz at 3 meters in any direction. Further, an AVIS, when in its operating position, shall not produce a field strength greater than 400 microvolts/meter/MHz at 3 meters in any direction within ± 10 degrees of the horizontal plane. In addition to the provisions of Part 3.2 of this Annex, the field strength of radiated emissions outside the frequency range swept by the signal shall be limited to a maximum of 100 microvolts/meter/MHz at 3 meters, measured from 30 MHz to 20 GHz for the complete system. The emission limits in this paragraph are based on measurement instrumentation employing an average detector. The provisions in Part 1.5 of this Annex for limiting peak emissions apply.

3. The minimum sweep repetition rate of the signal shall not be lower than 4000 sweeps per second, and the maximum sweep repetition rate of the signal shall not exceed 50,000 sweeps per second.

4. An AVIS shall employ a horn antenna or other comparable directional antenna for signal emission.

5. Provision shall be made so that signal emission from the VIS shall occur only when the vehicle to be identified is within the radiated field of the system.

3.5.20 Unlicensed National Information Infrastructure Devices

1. **General:**

These paragraphs set out the regulations for Unlicensed National Information Infrastructure devices operating in the 5.15-5.35 GHz and 5.725-5.825 GHz bands. The provisions of all other parts of this Annex apply to unlicensed devices except where specific provisions are contained in this part. The requirements of this part apply only to the radio transmitter contained in the Section 3.5.20. Other aspects of the operation of such devices may be subject to requirements contained elsewhere in this annex. In particular, such devices that include digital circuitry not directly associated with the radio transmitter in this section are also subject to the requirement for unintentional radiators found elsewhere in this annex.

2. **Definitions:**

Average Symbol Envelope Power: The average symbol envelope power is the average, taken over all symbols in the signaling alphabet, of the envelope power for each symbol.

Digital Modulation: The process by which the characteristics of a carrier wave are varied among a set of predetermined discrete values in accordance with a digital modulating function as specified in document ANSI C63.17-1998.

Emission Bandwidth: For the purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emission bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

Peak Power Spectral Density: The peak power

spectral density is the maximum power spectral density, within the specified measurement bandwidth, within the device's operating band.

Peak Transmit Power: The maximum transmit power as measured over an interval of time of at most 30/B (where B is the 26-dB emission bandwidth in MHz) or the transmission pulse duration of the device, whichever is less, under all conditions of modulation.

Power Spectral Density: The power spectral density is the total energy output per unit bandwidth from a pulse or sequence of pulses for which the transmit power is at its peak or maximum level, divided by the total duration of the pulses. This total time does not include the time between pulses during which the transmit power is off or below its maximum level.

Pulse: A pulse is a continuous transmission of a sequence of modulation symbols, during which the average symbol envelope power is constant.

Transmit Power: The total energy transmitted over a time interval of at most 30/B (where B is the 26 dB emission bandwidth of the signal in hertz) or the duration of the transmission pulse, whichever is less, divided by the interval duration.

U-NII devices: Intentional radiators operating in the frequency bands 5.15 - 5.35 GHz and 5.725 - 5.825 GHz that use wideband digital modulation techniques and provide a wide array of high data rate mobile and fixed communications for individuals, businesses, and institutions.

3. **General Technical Requirements:**

a. Power limits:

(1) For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10logB (where B is the 26-dB emission bandwidth in MHz). In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10logB (where B is the 26-dB emission bandwidth in MHz). In addition, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(3) For the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed 1 W or 17 dBm + 10logB (where B is the 26-dB emission bandwidth in MHz). In addition, the peak power spectral density shall not exceed 17 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain up to 23 dBi without any corresponding reduction in the transmitter peak output power or peak power spectral density. For fixed, point-to-point U-NII transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in peak transmitter power and peak power spectral density for each 1 dB of antenna gain in excess of 23 dBi would be required. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

NOTE: The NTIA strongly recommends that parties employing these devices to provide critical communications services should determine if there are any nearby Government radar systems that could affect their operation.

(4) The peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for

any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement conforming to the above definitions for the emission in question.

(5) The peak power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

(6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

b. Undesirable Emission Limits: Except as shown in Paragraph b.(6) of this Section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5.15-5.25 GHz band.

(3) For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27 dBm/MHz.

(4) The above emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

(5) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 3.4. Further, any devices using an AC power line are required to comply also with the conducted limits set forth in Section 3.3.

(6) The provisions of Section 3.2 of this annex apply to intentional radiators operating under this section.

(7) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

c. The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met.

d. Any device that operates in the 5.15-5.25 GHz band shall use a transmitting antenna that is an integral part of the device.

e. Within the 5.15-5.25 GHz band, devices will be restricted to indoor operations to reduce any potential for harmful interference to aeronautical radionavigation and co-channel MSS operations.

f. Devices are subject to the radio frequency radiation exposure requirements specified in Section 8.2.28, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications

for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the NTIA upon request.

g. Manufacturers of these devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

4.0 Conversion Formulas

To convert from EIRP (i.e., product of the power supplied to the antenna and the antenna gain) values to field strength use the formula:

$$E = \frac{(30 \; X \; P_t \; X \; G_t)^{1/2}}{R}$$

where:

E = Field Strength, V/m
P = Power supplied to the antenna, watts
G = Numerical antenna gain ratio relative to isotropic at the given frequency
R = Distance, meters

This formula assumes wave spreading (i.e., "free-space") losses only.

The power supplied to the antenna is the transmitter output power less any line losses. In most cases, the line losses for these devices are difficult to quantify.

Example: Determine if a field disturbance sensor operating at a frequency of 915 MHz with a power output of 1 mW, no line losses and an antenna gain of 3 dBi meets the field strength criterion in Section 3.5.16 of this Annex.

Step 1: Convert the decibel antenna gain to a numerical ratio.

$$\text{Numerical gain ratio} = 10^{(\text{decibel value}/10)}$$
$$= 10^{(3/10)}$$
$$= 2$$

Step 2: Use the EIRP to field intensity conversion formula.

$$E = \frac{(30 \; X \; .001 \; X \; 2)^{1/2}}{3}$$

$$E = 0.0816 \; V/m = 81{,}600 \; \mu V/m$$

Since the criterion is 500,000 μV/m at 3 m, the device meets the indicated criterion in Section 3.5.16 and can be operated without further authority from the Assistant Secretary as indicated in Part 7.9.

5.0 CROSS-REFERENCE OF NON-LICENSE DEVICE STANDARDS IN ANNEX K AND THOSE IN THE FCC CFR 47 PART 15.

ANNEX K NUMBER		PART 15 NUMBER
1.0	Introduction	N/A
1.1	Definitions (some new definitions)	15.3
1.2	Incidental Radiators	15.13
1.3	Susceptibility to Interference	15.17
1.4	Labeling Requirements	15.19
1.5	Measurement Detector Functions	15.35
2.0	Unintentional Radiators	N/A
2.1	Conducted Limits	15.107
2.2	Radiated Emission Limits	15.109
3.0	Intentional Radiators	N/A
3.1	Antenna Requirements	15.203
3.1.1	External Radio Frequency Power Amplifiers and Antenna Modifications	15.204
3.2	Restricted Bands of Operation	15.205
3.3	Conducted Limits	15.207
3.4	Radiation Emission Limits, General Requirements	15.209
3.5	Radiation Emission Limits, Additional Provisions	N/A
3.5.1	Additional Provisions to the General Radiation Limits	15.215
3.5.2	Operation in the Band 160-190 kHz	15.217
3.5.3	Operation in the Band 510-1705 kHz	15.219
3.5.4	Operation in the Band 525-1705 kHz	15.221
3.5.5	Operation in the Band 1.705-10 MHz	15.223
3.5.6	Operation in the Band 13.553-13.567 MHz	15.225
3.5.7	Operation in the Band 26.96-27.28 MHz	15.227
3.5.8	Operation in the Band 40.66-40.70 MHz	15.229
3.5.9	Operation in the Band 40.66-40.70 MHz and above 70 MHz	15.231
3.5.10	Operation in the Bands 46.60-46.98 and 49.66-50.00 MHz	15.233
3.5.11	Operation in the Band 49.82-49.90 MHz	15.235
3.5.12	Operation in the Bands 72.0-73.0, 74.6-74.8 and 75.4-76.0 MHz	15.237
3.5.13	Operation in the Band 88-108 MHz	15.239
3.5.14	Operation in the Band 174-216 MHz	15.241
3.5.15	Operation in the Band 890-940 MHz	15.243
3.5.16	Operation in the Bands 902-928, 2435-2465, 5785-5815, 10500-10550, and 24075-24175 MHz	15.245
3.5.17	Operation in the Bands 902-928, 2400-2483.5, and 5725-5850 MHz (some cross-outs and highlighted areas)	15.247
3.5.18	Operation in the Bands 902-928, 2400-2483.5, 5725-5875 MHz and 24.0-24.25 GHz	15.249
3.5.19	Operation in the Bands 2.9-3.26, 3.267-3.332, 3.339-3.458, and 3.358-3.6 GHz	15.251
3.5.20	Unlicenced National Information Infrastructure Devices	15.401
3.5.20.2	U- NII Definitions	15.403
3.5.20.3	U- NII General Technical Requirements	15.407
4.0	Conversion Formulas (corrected an error)	N/A

(Last Page in Annex K)